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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Deer Use Changes after Root Plowing in Arizona Chaparral

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Deer spent one-fourth to one-half as much time on root-plowed chaparral pastures seeded to lovegrass (80 acres) as in adjacent brushfields. Although high-quality forbs, of low availability in intact brush, increased greatly on treated southerly exposures, deer showed no apparent preference for these slopes. North and southeast exposures were used most heavily during spring and summer in intact brush, while south-facing slopes were used more heavily in fall and winter. Pellet-group counts showed no marked relationship between deer use and distance from cover up to 300 yards.

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Chaparral occupies more than 4 million acres in central Arizona. The type occurs generally between 3,000 and 6,000 feet elevation, below juniper woodland or pine forest and above desert shrub or desert grassland. Management has emphasized range forage, watershed, and wildlife habitat values. Brush control, primarily to enhance livestock carrying capacity, water yield, and fire control, has become a prominent part of chaparral management programs on public lands.

Impacts of chaparral manipulation activities on wildlife, particularly deer, are the subject of considerable regional concern and research. The present study was an effort to assess deer response to conversion of shrub types to semipermanent grassland by mechanical methods on areas of moderate size. Root plowing effectively removed sprouting shrubs by grubbing subterranean rootcrowns; these species reestablish very slowly by seed.

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The Study Area

Pond [1969] has described the biotic and physical aspects of the Tonto Springs Range area upon which this study was superimposed. Briefly, the area is characterized by hot summers and cool winters. Convectional storms in midsummer usually separate the very dry May-June and October-November periods. Precipitation is less than 18 inches annually, about equally divided between summer and winter patterns. Elevation is slightly below 5,000 feet, yet chaparral yields to desert grassland only a few hundred feet lower as a result of low effective precipitation and soil differences.

Temperature data are not available for the immediate study area. Mean temperature is about 35° F in January, 75° F in July. Extremes generally lie between 0° F and 100° F.

Soils are derived predominantly from granite outwash. They are residual, fine-textured, and shallow on the low ridges, alluvial, fine to coarse, and deep in swales. The area is drained to the southwest. Ridge lines trend southwest so most slopes face south-southeast or north-northwest.

Chaparral at Tonto Springs is relatively low in height, density, and species diversity. Shrub

live oak[2] contributes most of the ground cover. It supplies abundant low-value browse and variable acorn crops of considerable forage value in midsummer. Much smaller but significant amounts of four other shrubs — skunkbush, hairy mountainmahogany, desert ceanothus, and wait-a-bit — occur as scattered individuals or sometimes dominate small stands. The first three are important browse for deer; wait-a-bit is seldom used. Cliffrose, Apache-plume, pointleaf manzanita, and alligator juniper are present but contribute little, quantitatively, to total cover or browse values.

Herbaceous understories in mature chaparral are poorly developed, especially on north-facing slopes. A number of cool- and warm-season grasses and scattered forbs occur on south-facing slopes and in swales. When shrubs are killed, particularly with considerable soil disturbance, a profusion of annual forbs rapidly becomes established.

Mule deer use the area yearlong, but concentrate most heavily during spring and summer. Compared to the treated pastures, cattle use was very light in adjacent chaparral (approximately 25:1).

Methods

The Tonto Springs Range study consisted of three replicates of four grazing comparisons in fenced pastures ranging from 40 to 200 acres. Root plowing was completed in 1961. Treated pastures were 40 or 80 acres in size.

Only the three 80-acre root-plowed units seeded to lovegrass were judged suitable for evaluating deer use differences. These pastures were selected on the basis that they were sufficiently large to demonstrate any correlations between deer use and distance from intact cover.

Root plowing reduced shrub density about 80 percent. Surviving shrubs, mostly shrub live oak, were hand treated with fenuron for a total kill in excess of 95 percent. However, some shrubs remained in all pastures. Both weeping and Lehmann lovegrasses were seeded, but only weeping lovegrass successfully established.

Vegetation Sampling

Treated and intact chaparral were compared through estimates of (1) shrub cover, (2) forage production, and (3) plant composition. Shrub canopy cover percentage and maximum height were estimated by species on 10- by 10-foot quadrats, using the permanent pellet-group transect stakes (described below) as plot markers. Forty plots were sampled for each slope exposure on both treated and intact stands.

Because forage production varied widely by season, plots were clipped at 3-month intervals. Ovendried weights of herbaceous forages by species, excluding seeded lovegrasses, were obtained on 9.6-foot[2] circular plots during 1968. Forty plots were clipped for each exposure in treated and intact stands using pellet-group-count transect stakes as plot markers.

Pellet-Group Counts

Fecal counts have been widely adopted as indexes of population size and range use (Eberhardt and Van Etten 1956, McCain 1948, Rogers et al. 1958, Smith 1964). Sampling intensities required for acceptable population estimates vary by density of groups, size of area, desired accuracy, and many other factors. Most studies indicate the need for large samples despite high populations and acceptance of relatively broad confidence limits on the estimate.

Deer densities in Arizona chaparral are low, and since man-hour costs to obtain precise estimates are prohibitive, sampling was minimal compared to those areas where the technique was developed. However, deer-use differences in the magnitude of two to three times were hypothesized between intact chaparral and root-plowed areas. Population estimates within ± 20 percent of the mean (95 times out of a 100) are sufficient in view of the large but indeterminate sampling error inherent in the fecal-count technique. Thus it was decided, in advance of sampling, that unless a difference exceeded the lowest population estimate by 100 percent, habitat selection had not changed significantly despite a considerable alteration of that habitat.

Sampling units consisted of permanent belt transects (10.89 by 400 feet or 1/10 acre) divided into four 100-foot segments. Ten transects located in treated and adjacent native chaparral parallel to and at 100-foot intervals from the boundary fence formed the basis for determining size-of-treatment effects on deer-use patterns. Transects were mechanically spaced with random starts along the treatment boundary. A tape stretched between permanent stakes, marking each 100-foot segment, served as the midline of the belt transect. Scattered or peripheral groups were counted if more than 25 individual pellets fell within the transect. Groups were cleared initially, then counted and cleared at 3-month intervals for 3 years.

[2]*Common and botanical names of plants mentioned are listed at the end of this report.*

Shrub live oak dominated the low chaparral at the Tonto Springs site. Herbaceous understories were poorly developed.

Root plowing plus followup chemical treatment reduced shrub density over 95 percent. Weeping lovegrass was established by seeding.

In addition, pellet counts showed a selection by deer for south exposures on root-plowed pastures and north slopes in intact chaparral. To verify this observation, five prevalent slope aspects — southeast, south, southwest, northwest, and north — were sampled. Twenty 100-foot transects located by random starts on these exposures in two of the paired pastures provided a better picture of habitat segment selection by deer.

Treatment Effects

Deer-habitat values are difficult to define in either chaparral or root-plowed stands. At best, "good" habitat is judged on vague criteria, and losses in one value may be more than compensated by increases in another (for instance, cover reduction may be offset by increased herbaceous forage production). Differences in vegetation on the two areas are sufficient to make objective measurements and subjective assessment of impacts important to land managers in their decisionmaking process.

Vegetation Complex

Root plowing, plus fenuron followup, strongly reduced shrub frequency and cover. Frequency (expressed as presence in 10- by 10-foot plots) averaged almost 100 percent for shrub live oak and 70 percent for skunkbush in untreated stands. Frequency of these species was reduced nearly in half on root-plowed slopes (table 1). Response of other woody plants was more variable; hairy mountainmahogany was nearly eliminated on all slopes, while broom snakeweed and wait-a-bit were reduced on some slopes and increased on others.

Coverage estimates revealed more about treatment impacts than did frequency, at least 5 to 10 years after treatment. Total shrub canopy cover averaged about 50 percent on intact stands and less than 10 percent on root-plowed areas. Shrubs in treated stands were half as tall as those in adjacent untreated brush.

Herbaceous species changed more markedly than shrubs. Production of forbs and native grasses increased greatly on southerly exposures (fig. 1), averaging over 300 pounds per acre in treated pastures compared to about 50 pounds per acre in chaparral. Production differences on northerly exposures were small, production was actually higher on untreated north slopes. Pond[3] estimated seeded lovegrass pro-

[3] *Unpublished production plot data are on file at the Forest Hydrology Laboratory, Rocky Mountain Forest and Range Experiment Station, Tempe, Arizona.*

Table 1.--Treatment effects on woody plants in root-plowed stands compared to intact chaparral, Tonto Springs, Arizona

Treatment and exposure	Mean maximum height	Mean cover	Frequency (10- by 10-foot plots)				
			Shrub live oak	Skunkbush	Mountainmahogany	Snakeweed	Wait-a-bit
	Inches		*Percent*				
TREATED (ROOT PLOWED):							
SE	29	5	53	30	0	30	35
S	20	2	35	33	5	33	38
SW	23	3	30	28	0	53	32
NW	30	9	58	53	0	83	0
N	32	11	58	48	5	58	3
Mean	27	6	47	38	2	51	22
UNTREATED:							
SE	48	48	93	58	75	50	45
S	50	46	100	75	35	78	68
SW	55	45	98	45	40	50	28
NW	62	57	100	88	55	43	23
N	56	50	98	70	50	73	5
Mean	54	49	98	67	51	59	34

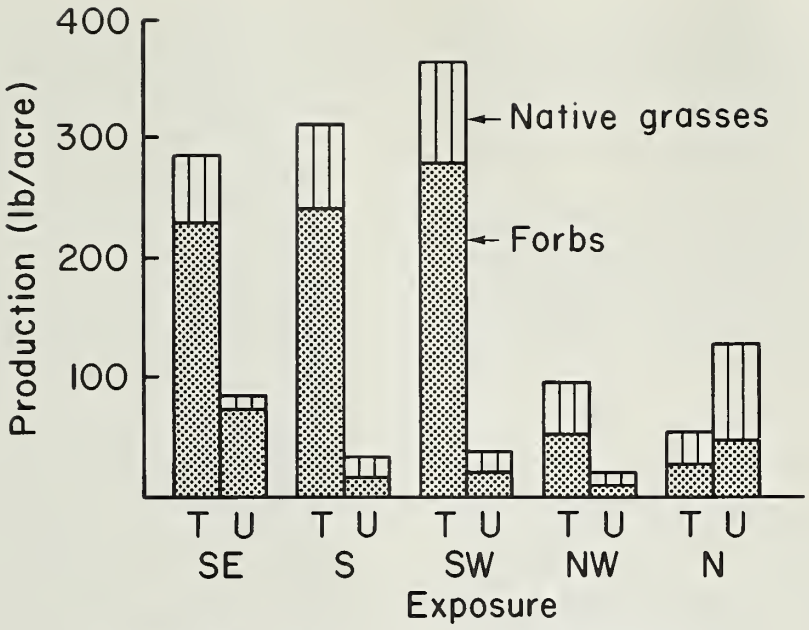

Figure 1.—Forb ond gross production, excluding seeded lovegrass, from exposure plots in root-plowed chaparral (T) and untreated chaparrol (U).

duction at about 1,200 pounds per acre. Thus total herbaceous forage production on treated south slopes apparently was 20 to 30 times greater than in intact chaparral. Deer use lovegrass only lightly, however, so effective increases in usable forage were more on the order of sixfold.

Deer Use Patterns

Deer consistently used treated areas less (table 2). Time spent by deer on the root-plowed pastures was roughly one-half to one-fourth that in intact brush. Except for the 1967 estimates, which were affected by a severe, early-December storm, the deer densities on untreated chaparral were relatively uniform. Year-to-year differences on root-plowed areas were highly variable, possibly reflecting fluctuations in production of preferred forage species. Precipitation timing and temperature strongly influenced forb growth on the treated areas. Dry, cold winters produced little spring growth of forbs.

Table 2.--Deer density estimates on treated (root plowed) and intact chaparral, Tonto Springs, Arizona

Sample and treatment	[1]1966	1967	1968	1969	Mean
	Deer per section per year				
PARALLEL TRANSECTS:					
Treated	7.5	1.7	0.7	--	3.3
Untreated	10.0	3.6	8.0	--	7.2
EXPOSURE TRANSECTS:					
Treated	--	--	1.4	2.7	2.1
Untreated	--	--	9.3	8.2	8.8

[1]Counts actually are for a period from April through March of the next year.

The value to wildlife of "edges" where vegetation types or successional stages meet is almost axiomatic among biologists. Indeed, many studies have shown these areas receive greater use by deer and other big game (Reynolds 1966, Taber and Dasmann 1958). However, pellet-group transects parallel to and in 100-foot increments from the treatment boundary did not indicate any preference by deer for the immediate border area (fig. 2). If anything, there was a slightly negative response in the first 100 feet out in either direction from the treatment boundary.

Within the limitation of the 80-acre pastures sampled, there was no indication that use declined toward the center of the treatment until the 10th transect. This suggests treatments of 80 acres or less are completely used in this area. At some greater size, use levels likely would decline as distance from cover increased.

Exposure plot samples showed a heavier use of southeast and north slopes in spring and summer in untreated brush, presumably because they receive less intense insolation. Conversely, south and southwest slopes were used slightly more in winter, northwest slopes were used least.

Effects of slope on deer use in root-plowed areas were weak, although north slopes were more important in spring. Uniform use of treated slopes was not expected, since forb production was much higher on southerly exposures (fig. 1).

Discussion

The consistently lower deer use of 80-acre root-plowed sites, specifically those with chemical followup, could, simplistically, be interpreted as a loss of habitat values in the magnitude of 50 to 75 percent. Such a view is questionable, however, because pellet-group counts index time spent on areas, not relative values received. That is, in comparing root-plowed pastures to intact brush we are, in essence, judging areas where deer only feed against areas where feeding as well as all other activities are carried on (resting, ruminating, etc.).

Although it can be stated with reasonable assurance that deer spend from one-half to one-fourth as much time on heavily treated areas as in surrounding brushfields, what is gained during this period may compensate for reduced cover and other values (provided treatment size is moderate). Moreover, root plowing without chemical control of surviving shrubs would have less impact on deer use, as noted by Loe and White (1972). Much of the increased forb production on root-plowed pastures consists of high-quality species of low occurrence in brushfields. These are the kinds of forages most needed to supplement browse diets that are often low in certain nutrients (Swank 1958, Taber and Dasman 1958, Urness et al. 1971).

Although this study was limited in scope, several guidelines can be offered to chaparral land managers whose objectives are to improve livestock carrying capacity and retain deer habitat values. First, regardless of acreage treated, the control areas should not exceed about 300 to 400 yards in width. The obvious value of brushland areas suggests a fairly high percentage of chaparral be left intact, although no absolute formula can be provided. Until more exhaustive studies are made, perhaps no more than 50 percent of any area should be treated. This recommendation is consistent with the value of brushfields for livestock recognized by Pond et al. (1968).

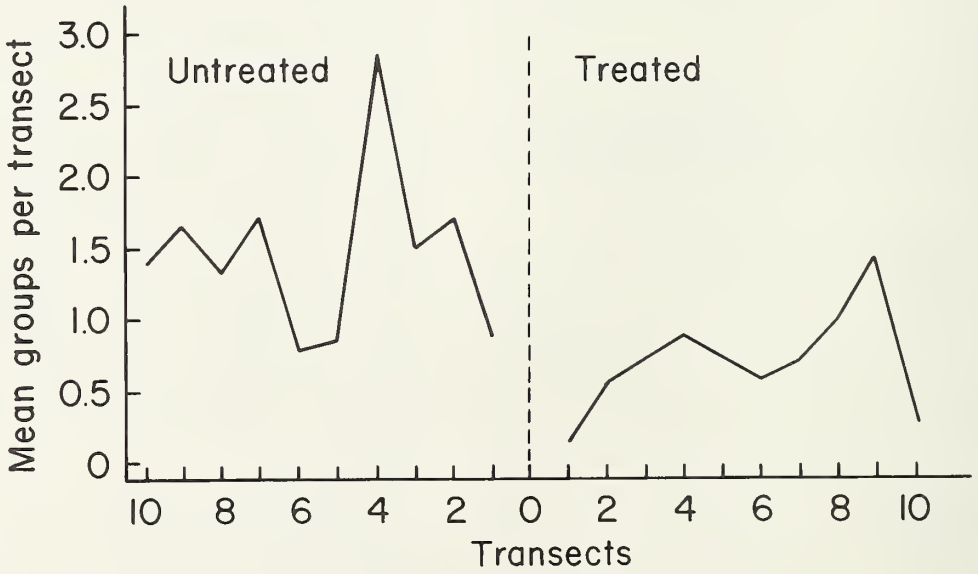

Figure 2.—Mean deer pellet groups on transects parallel to and in 100-foot increments from the root plow: chaparral boundary.

Furthermore, specifying that only certain slopes be treated is not advisable. The data indicate that deer shift seasonally in the habitat segment they select (fig. 3). North slopes in chaparral were used more extensively in spring and summer, while south-facing slopes were more important in fall and winter. Therefore, some intact brush should be left on all exposures in reasonable juxtaposition. In this area, characterized by numerous low parallel ridges, it is possible to root plow in irregular strips and small patches, designing unobtrusive patterns which treat and retain some areas on all slope situations.

Large treated blocks, which are objectionable from almost any esthetic criterion, are not compatible with optimum diversity. Diversity is an important consideration since much criticism of public rangeland improvements has alleged, sometimes unfairly, that they benefit the livestock industry at the expense of wildlife. Loe and White (1972), however, showed that root plowing increased slightly the number of bird species represented in the general area, and increased total bird numbers over 30 percent. Small mammal populations differed only slightly between root-plowed and intact stands.

In conclusion, there is a potential adverse impact of root plowing on habitat values for deer and other wildlife only if treatments are large and complete. Properly done, treatments should not reduce overall populations if sufficient cover is retained. The creation of a high-quality forage resource in treated pastures no doubt increases the value of adjacent chaparral, but it is not certain that this resource affects deer population levels materially.

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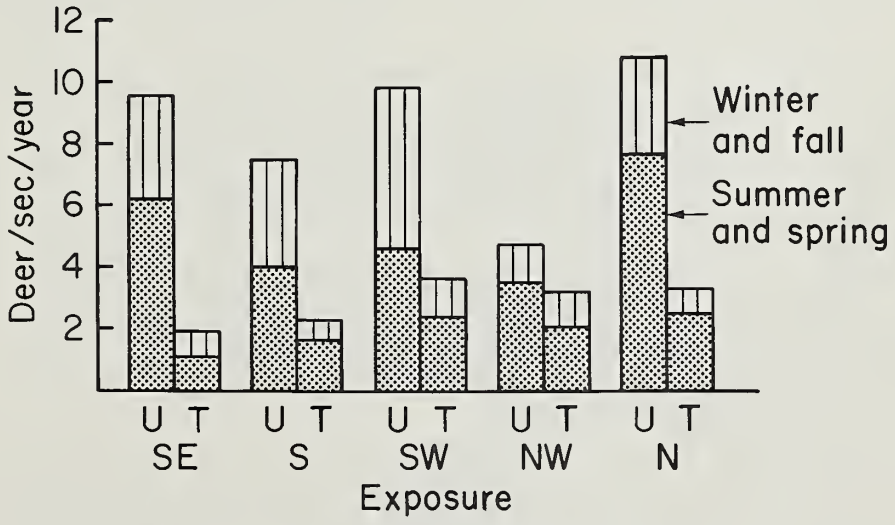

Figure 3.—Seasonal deer use of predominant slopes in untreated chaparral (U) and root-plowed pastures (T), in terms of the seasonal ratio of total use expressed as deer per section per year.

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Common and Botanical Names of Plants Mentioned

Apache-plume	*Fallugia paradoxa* (D. Don) Endl.
Ceanothus, desert	*Ceanothus greggii* A. Gray
Cliffrose	*Cowania mexicana* D. Don
Juniper, alligator	*Juniperus deppeana* Steud.
Lovegrass, Lehmann	*Eragrostis lehmanniana* Nees
Lovegrass, weeping	*Eragrostis curvula* (Schrad.) Nees
Manzanita, pointleaf	*Arctostaphylos pungens* H.B.K.
Mountainmahogany, hairy	*Cercocarpus breviflorus* A. Gray
Oak, shrub live	*Quercus turbinella* Greene
Skunkbush	*Rhus trilobata* Nutt.
Snakeweed, broom	*Gutierrezia sarothrae* (Pursh) Britt. & Rusby
Wait-a-bit	*Mimosa biuncifera* Benth.

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